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Original Article

Solvent-dehydrated cadaveric dermis: a new allograft for pubovaginal sling surgery

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Abstract

Aim: The aim of this study was to evaluate the efficacy of solvent-dehydrated cadaveric dermis in pubovaginal sling surgery for the first time in the literature.

Methods: Twenty-five women with stress urinary incontinence underwent pubovaginal sling surgery using 2 × 12 cm allograft dermis. Preoperatively, all patients were evaluated by a detailed urogynecologic evaluation, voiding diary, pelvic examination and urodynamic investigation. Outcome was assessed by the Urogenital Distress Inventory short form and standardized follow-up questionnaires.

Results: Twenty (80%) patients were cured of stress incontinence symptoms. Seventeen wore no pad and three reported occasional stress urinary incontinence and used no or one pad at a mean follow up of 12 months. Five (20%) patients in our series experienced the same amount of leakage as before the surgery. Seventy-six percent of the patients indicated that urinary incontinence was no longer negatively affecting their daily life and were satisfied with the procedure.

Conclusions: Questionnaire-based assessment of outcome suggests that solvent-dehydrated cadaveric dermis is effective in the treatment of stress urinary incontinence. However, larger and comparative prospective studies with long-term results and randomized comparison of tissue preparation techniques are warranted.

Key words allograft dermis, stress, sling, tissue processing, urinary incontinence.

Introduction

Pubovaginal sling has been shown to be an effective and durable treatment for sphincteric incontinence.[1] Although techniques vary, the common goal in pubovaginal sling is to restore sufficient outlet resistance to the intrinsically compromised urethra while avoiding urethral obstruction and allowing spontaneous micturition.[2] Autologous tissues, either rectus fascia or fascia lata, have been proven to be the most effective grafts with long-term success.[2,3] However, tissue harvesting with associated morbidities are the major disadvantages of this material.[2,4]

Recently, efforts to decrease the morbidity related to autologous tissue have lead to a re-exploration of the concept of transplantation of allograft tissue as a sling material.[5,6] The use of cadaveric fascia initially appeared to eliminate some of the limitations experienced with the use of autologous fascia and had equal success rates.[4,6,7] However, some of the investigators have found the results to be not so promising and questioned the durability of the cadaveric fascia allografts.[8,9] Different results were attributed to basic mechanical properties of these tissues or to the tissue processing techniques, such as solvent-dehydration or freeze-drying.[10,11] Thus, the disagreement prompted the investigators to use new allogenic materials, focusing on the use of either more durable grafts or tissues processed with different techniques.

In the present study, we evaluated the efficacy of solvent-dehydrated allograft dermis use in pubovaginal sling since it became available in early 2002 and assessed treatment outcomes with validated and detailed questionnaires. To our knowledge, this is the first report ever describing this graft material.

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Methods

Between January 2002 and May 2003, a total of 25 patients with stress urinary incontinence underwent pubovaginal sling surgery with solvent-dehydrated cadaveric dermis (Axis-Tutoplast, Mentor, Santa Barbara, CA, USA). The procedure was described in detail and all subjects gave informed consent. Preoperative evaluation included a detailed history, urogynecologic examination, voiding diary and video urodynamic investigation with measurement of Valsalva leak point pressure (VLPP). Stress urinary incontinence was classified as described previously.[3] Patients with type III (sphincteric incontinence, VLPPs < 60 cmH_2O) or type II-III (mixed type with elements of both urethral hypermobility and sphincteric incontinence; VLPPs of 60–90 cmH_2O) SUI were managed by pubovaginal sling.

A 12 × 2 cm strip of cadaveric dermis was soaked in an antibiotic saline solution for at least 15 min before the implantation. The processing of this allograft includes several steps: after tissue harvesting from carefully selected donors, it is defatted by 10 min ultrasound in pure acetone. To destroy and remove the cells, osmotic treatment was performed which was followed by hydrogen peroxide to destroy noncollagenous proteins and inactivate viruses. The dermis was dehydrated in an ambient air-drying chamber, and finally sterilized by gamma radiation with an average dose of 17.8 KGy. The procedure was performed with the patient in the dorsal lithotomy position. A Foley catheter was placed in the urethra and the balloon inflated with 10–20 mL of water to facilitate palpation of the bladder neck. An inverted U-shaped incision was made in the anterior vaginal wall with the distal limit being at the midurethral level and extending proximally up to the bladder neck. A vaginal flap was raised from the periurethral fascia, and the dissection was continued laterally on each side securing any injury to the urethra or bladder. The dissection in the retropubic space was kept minimal enough to pass the Stamey needles. A small incision was made 1–2 cm above the pubic symphysis and carried down to the rectus fascia. Dermal graft ends were anchored with #1 polypropylene with a horizontal mattress suture. Then, a Stamey needle was passed from the suprapubic incision keeping close to the pubic bone, and guided into the vaginal wound on each side. The polypropylene sutures were transferred to the suprapubic incision. The graft is now positioned under the proximal urethra and the bladder neck. It was anchored to the underlying periurethral fascia using 4/0 chromic catgut to prevent sling displacement. Indigocarmine was given intravenously and cystoscopy was performed to exclude any bladder or ureteric injury. The polypropylene sutures were tied over the rectus fascia with enough tension to pass at least two fingers under the knot. The vaginal and suprapubic incisions were closed and the Foley catheter was replaced with a vaginal pack left in place. The catheter was removed on postoperative day 1 and a voiding trial was given. Patients in urinary retention or with high postvoid residual volumes (>100 mL) started previously taught clean intermittent catheterization (CIC).

Follow up included a routine examination 1 week, 1 and 3 months, and every 6 months postoperatively. The Urogenital Distress Inventory (UDI-6) short form and standardized follow-up incontinence and treatment satisfaction questionnaires were completed by all patients.[12] Treatment outcomes were categorized as described previously: cured – no leakage and using no pads; improved – slight leaking, small amounts, or using 0–1 pad; and failed – more than one pad use daily.[13] The procedure was considered to be 'successful' in patients who were cured and improved. Mean time of hospital stay, associated pelvic floor reconstructive surgeries, complications, incidence of urinary retention, self catheterization time and persistency of urge and de novo urgency or urge incontinence were also assessed.

Results

Patient demographics are summarized in Table 1. The mean postoperative follow up was 12 months (range 8–22 months). A total of 17 patients showed different

Table 1 Patient characteristics

Characteristic	
Demographics [mean (range)]	
Age (years)	62 (39–77)
No. preoperative pads/day	3 (0–10)
Duration of incontinence (months)	24 (2–180)
VLPP (cmH_2O)	59 (21–90)
Previous pelvic surgery [no. patients (%)]	
Hysterectomy	14 (56)
Retropubic suspension	1 (4)
Pubovaginal sling	1 (4)
Type of incontinence [no. patients (%)]	
II/III	13 (52)
III	12 (48)
Previous anti-incontinence surgery [no. patients (%)]	
Collagen injection	2 (8)
Burch colposuspension	1 (4)
Pubovaginal sling	1 (4)

VLPP, valsalva leak point pressure.

degrees of pelvic prolapse. Of these, eight (32%) patients had significant pelvic organ prolapse and two underwent cystocele repair, whereas four had rectocele and two had enterocele repairs. Abdominal sacrocolpopexy with a bone-anchoring technique was performed in three patients. One patient underwent vaginal hysterectomy at the time of the sling surgery. Mean duration of hospital stay was 1.5 days (range 1–4 days). In three patients, because of immobilization, the Foley catheter was left in place for more than 1 day. Mean time of catheter removal was 1.5 days (range 1–7 days). The treatment satisfaction questionnaire (see Appendix) was answered by all patients: 17 patients reported wearing no pad and 3 had occasional stress urinary incontinence and used no or one pad (Protection required during the day – Follow-Up Incontinence Questionnaire, Quest. No. 6). Similarly, the same questionnaire revealed that five (20%) patients in our series experienced same amount of leakage as before the surgery. Four out of five patients failed within 6 months of surgery and one patient failed after 10 months. The procedure was successful in 20 (80%) patients. The questionnaire revealed that 76% of the patients were satisfied with the treatment outcome and would recommend sling surgery. Eight percent of patients in our series reported that, with their current continence and medical status, they would have sling surgery again.

There were no intraoperative complications. Three patients developed mild suprapubic or vaginal infection and were treated by appropriate antibiotics without any sequelae. Seven (28%) patients had high post void residual urine following removal of the Foley catheter and required CIC until their residual urine volumes measured less than 60 mL for a mean time of 9.4 days (range 4–42 days). As ascertained by their answers to questions 1, 3 and 7 in the questionnaire (see Appendix), of the 10 patients with preoperative urge symptoms, 7 had persistent symptoms postoperatively, 1 (10%) experienced intermittent urgency and 2 (20%) patients had resolution of urge symptoms. Three (12%) patients developed de novo urgency or urge incontinence and were treated by bladder drills and anticholinergic medication.

Questionnaire-based assessment of symptom distress did not reveal any significant negative effect on quality of life of these patients. Thirty-six percent of the patients had moderate to severe symptoms of frequent urination, whereas the majority of the patients showed slight or no symptoms of frequent urination (Fig. 1). UDI-6 revealed that 20 (80%) patients had no or slight difficulty in emptying their bladders and only 1 (4%) patient had experienced moderate pain or discomfort after the procedure. The effects of the surgery as evaluated by the UDI-6 questionnaire are summarized in Figure 1.

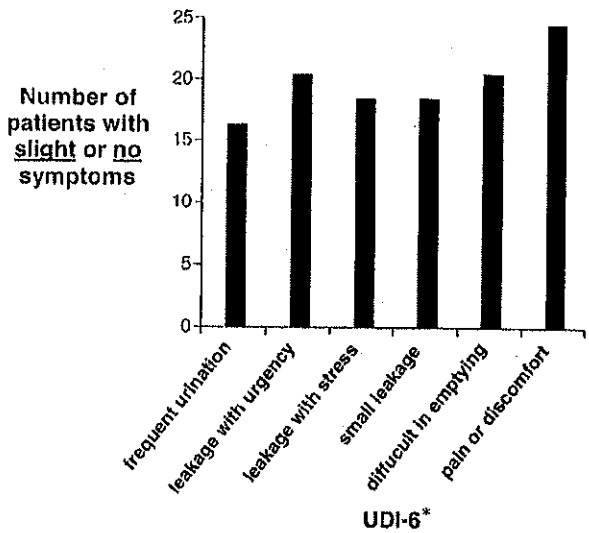

Fig. 1 Postoperative quality of life assessment of patients by Urogenital Distress Inventory (UDI-6)* short form

Discussion

Presently, the two main allograft sling materials are cadaveric fascia lata and cadaveric dermis.[2] Although the use of allograft fascia lata for pubovaginal sling initially suggested equal efficacy to autograft fascia on a short-term basis, and revealed 87–98% success rate, reports which describe disappointing results have been increasing in literature recently.[6,9,14,15] Chaikin and Blaivas reported the first failure of a cadaveric fascial sling[16] followed by Fitzgerald *et al.* demonstrating early failure of freeze-dried cadaveric fascia in 31% of their series.[15] Thus, the search for new sling materials is now intended to develop new allografts or to process tissues with alternative techniques.

Our cohort comprises patients with intrinsic sphincter deficiency treated by solvent-dehydrated cadaveric dermis. Although allograft dermis has been widely used in orthopedic surgeries, there are few reports describing its use in pubovaginal sling and to date no results of sling surgery using solvent-dehydrated cadaveric dermis are available.[10] In a study evaluating 10 patients treated by suburethral sling using cadaveric dermis, all were found to be continent at 6 weeks with no demonstrable stress incontinence on physical examination. Although follow up was at 3–8 months, authors reported their initial experience within first the 6 weeks and in a very

small group of patients. Moreover, the outcome was assessed by only physical examination, without using any validated questionnaire.[17] Since most studies using questionnaires were reported to have less favorable outcomes than those based on retrospective chart review,[2] our results with an 80% incontinence-free rate and a 76% overall satisfaction rate were shown to have reasonably comparable success rates to autograft and allograft materials.

There are two main factors affecting the durability and success of an allograft sling material: strength and processing technique of the tissue.[11,16] Cadaveric dermis was found to be omnidirectional with a random orientation of collagen in the papillary dermis, and the reticular layer has collagen perpendicular to the lines of tension. Although it has not been well studied, it has been reported that dermal grafts may have better suture pull-through capabilities because of their omnidirectional tensile strength.[18] There are different reports investigating the processing technique of allograft tissues: use of freeze-dried cadaveric fascia lata was reported to have significantly lower tensile strength and stiffness than solvent-dehydrated counterparts.[11] Similarly, Hinton *et al*. compared two groups of commercially available fascia lata allografts processed by solvent-dehydration and freeze-drying to evaluate the impact of tissue processing.[10] Significantly higher stiffness and higher maximum load to failure was found with the solvent-dehydrated as opposed to the freeze-dried fascia lata. On the contrary, Sutaria and Staskin reported that tissue processing had no effect on the mechanical properties of fascial tissues.[19] However, ice crystal formation during freeze-drying and/or gamma irradiation processes were shown to adversely affect collagen microstructure and have a negative influence on the integrity of the connective tissue macromolecules.[10,20] Similarly, Elliot and Boone found no evidence of rapid degradation of solvent-dehydated cadaveric fascia resulting in early recurrent incontinence and suggested continuing use of solvent-dehydrated cadaveric allograft.[4] Our results with a recent material processed by solvent-dehydration technique also favored use of allogenic tissues in pubovaginal sling surgery.

In vivo evaluation revealed that grafts undergo several steps of remodelization: initial degeneration, slow revascularization, fibroblastic proliferation, and gradual structural reorganization.[21] Other factors affecting the mechanical characteristics of allograft tissues are donor factors such as age, activity level, sex, and genetic predisposition.[10,22] The primary object of allograft fascia is to serve as a scaffold for the ingrowth of host tissues that results in replacement of the allograft.[9] During this process, several different factors affect the allograft maturation: antigenicity of the allograft, host versus graft reactions, lack of ideal graft remodeling, contamination by vaginal flora and undue stress.[15,23] Since these variables were controlled in the *in vitro* studies, we believe that the processing techniques used in the preparation of allografts becomes more important. Moreover, the success rate of any allogenic sling material may vary with individual variability and reactions following implantation of the graft. Thus, it is difficult to identify the failure of some of the allografts or to avoid their use for pubovaginal sling surgery.

Our patient population, with 64% prior pelvic surgery and with an average age of 62 years, revealed an 80% success rate. The overall satisfaction rate of 76% with cadaveric dermis encouraged further use of this material. Since current studies include data collection that incorporates the patient's subjective evaluation of the degree of satisfaction, and an objective component to evaluate the continence status and assessment of the impact of the treatment on quality of life, our success rate tends to be similar to those reported for allograft fascia and autologous tissues.[14,24] However, the aim of this study was neither to compare allograft dermis to other materials nor to claim that it is better than fascia. We evaluated the outcome of pubovaginal sling surgery with this particular type of biomaterial which is processed by a different technique. The major drawback of our study was the short follow-up time. However, most surgical failures are reported to present within the first 3–5 months following a pubovaginal sling and in our study, the majority (80%) of the patients in our series failed within 6 months.[25,26] Since cadaveric dermis became available in early 2002, we believe that our early experience will help in counseling and decision-making in the use of this allogenic tissue in pubovaginal sling surgery.

To our knowledge, we present the first experience related to solvent-dehdrated cadaveric dermis use in pubovaginal sling surgery. Our questionnaire-based assessment revealed this material to be a safe and effective alternative in treatment of stress urinary incontinence with comparable results to both autologous and allogenic tissues. However, larger and comparative prospective studies with long-term results are required to determine the durability of this biomaterial.

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Appendix

Follow-up incontinence questionnaire

1 Describe the nature of your leakage during the day.
2 Do you leak when you cough, sneeze, or perform physical activities?
3 Do you get a sudden uncontrollable urge to urinate that results in leakage?
4 How often do you urinate during the day?
5 How much leakage do you have during the day?
6 Protection required during the day?
7 Describe the nature of your leakage at night:
8 How many times per night do you wake from sleep to urinate?
9 How often do you leak urine at night?
10 Protection required at night?
11 Describe how you start your flow.
12 How often do you feel as though you empty your bladder completely?
13 How much improved is your urinary leakage now compared to before the surgery?
14 Overall, how satisfied are you with the results of your sling surgery?
15 Knowing what you know now, would you have the sling surgery again?
16 Would you recommend the sling surgery to a friend?